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An investigation of drugs abuse in sport performance

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ABSTRACT

Doping in performance sport is a complex and controversial issues. The secrecy that characterizes it hinders the implementation of epidemiological investigations. It involves the entire society. Moreover, the forces that conspire behind doping have always been able not only to identify new substances and new methods but also to steal the new scientific discoveries aimed at the treatment of diseases, for their illegal purposes. The fight against doping has had a strong push, in 2004, with the birth of the first World Anti-doping Code drafted by WADA. The laboratories, the Code, the Biological Passport and the ADAMS are important tools for the fight against doping. The aim study is to show the data relating to the consumption of drugs from 2003 to 2017. A number of the commonly used substances have been discussed and their risks and side effects reviewed. **Key words**: DOPING CONTROLS, DRUGS, SPORT, ANALYSIS, ILLICIT SUBSTANCES, LEGISLATION.

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INTRODUCTION

Sport performance today is the results of many factors, who playing an important role in the athletes' results (Mazzeo et al. 2016; Sjöqvist et al, 2008; Calatayud et al. 2007).

Moreover, Intensity training, talent, and an adequate diet represent the crucial factors for the success of athletes (Mazzeo et al 2016). Expert on performance sport define performance sport as the results a specific activity, usually competitions, as an extent to which a motor task limited by rules of a given sports discipline is accomplished (Altavilla et al, 2017, Raiola, 2017, Raiola, D'Isanto 2017, Tiziana et al, 2017, D'Isanto, 2016, Montesano et al, 2013).

The use of drugs to enhance performance in sports has certainly occurred since the time of the original Olympic Games [from 776 to 393 BC]. The derivation of the word 'doping' has origin to the Dutch word 'doop,' which is a viscous opium juice, the drug of choice of the ancient Greeks (Martínez-Sanz et al. 2017; Mazzeo & Volpe, 2016).

It seems that the term doping is derived from an ancient African dialect "doop" as meaning a mixture or a potion. The willingness to compromise the performance involved, as victims, even the animals. The Greek wrestlers and the Roman gladiators attempted to improve their own performance by taking mixtures of various types of plants or by eating sheep's testicles (Dilger et al, 2007). Doping means athletes taking illegal substances to improve their performances.

Moreover, doping is a complex phenomenon analysing the vast variety of substances, supplied through both legal and illegal trading routes and the extensive connections between the people involved in the network (Esseiva et al., 2007).

Drug abuse is one of the biggest problems in sports. It involves the repeated and excessive use of chemical substances to realize a certain effect. It can also be referred to as substance abuse or doping (Mazzeo et al, 2016).

Doping is increasingly a matter that concerns the whole society: it involves not only elite athletes but amateurs too, their friends and relatives, the medical staff, managers, chemists, biologists and pharmacists, pharmaceutical industries, clandestine laboratories and criminal organizations (Marclay et al., 2013; Mazzeo et al. 2017). The combination of sport and doping arouses negative reactions. An athlete who takes drugs to win is guilty of fraud and all the stakeholders immediately dissociate them from a sport not fair: the sponsors, for example, rescind their endorsements (Presidenza del Consiglio dei Ministri, 2010).

During the last 2 decades, progress in deciphering the human gene map as well as the discovery of specific defective genes encoding particular proteins in some serious human diseases have resulted in attempts to treat sick patients with gene therapy (Mazzeo & Volpe, 2016). There has been large attention on human recombinant proteins which were gene-engineered and produced in vitro (*insulin, insulin-like growth factor-1, erythropoietin, growth hormone*). These substances and methods also became improper tools for dishonest athletes (Santamaria S. et al., 2013). In fact, a new frontier reached by the doping is the use of genes.

According to the Anti-Doping Agency, substances and methods are banned when they meet at least two of the three following criteria: they improve performance, pose a threat to athlete health, or no respect the spirit of sport (Mazzeo et al. 2016; Santamaria et al. 2013).

The prohibited substances

The explosive spread of doping has triggered the response of the International Olympic Committee in 1960 (Botrè, 2008). At beginning, the first anti doping test were sporadic and not completely reliable. Fortunately, in 1999, thanks to the creation of the World Anti Doping Agency, it was finally created an organization with the sole purpose to fight this "cancer" of sport and consequently the situation of tests is changed (Dvorak J. et al. 2014; Valkenburg D. et al. 2014).

The World Anti-Doping Agency (WADA) was an international organization, that is established on November 10, 1999 with the aim to promote, coordinate, and monitor the fight against doping in sport in all its forms. In 2004, the aforementioned organization has harmonized the rules and regulations governing anti-doping across all sports and all countries for the first time through the issuance of a Code which defines the doping (Kayser B. et al., 2005). In accordance with the WADA Code, *doping is the presence of a prohibited substance or its metabolites or markers' banned; the use or the attempted use of a prohibited substances or a prohibited method; the refusing or the failing, without compelling justification, to submit to sample collection; the violation of applicable requirements regarding athlete availability for out-of-competition testing; the tampering or the attempting to tamper with any part of doping control; the possession of prohibited substances and prohibited methods; the trafficking or the attempted trafficking in any prohibited substance or prohibited methods; the administration or the attempted administration to any athlete of any prohibited methods or prohibited substances, or the assisting, the encouraging, the aiding, the abetting, the covering up or any other type of complicity involving an anti-doping rule violation or any attempted anti-doping rule violation.*

(WADA, 2017)

The Agency has compiled a list of banned substances and practices that is constantly updated. Now, WADA, for example, has identified more than two hundred banned substances currently divided into 10 classes (including the class S0) and three methods, as you can see in table 1 (Strano Rossi S., et al. 2011).

The most commonly used substances are androgenic agents such as anabolic steroids. (Mazzeo, 2016). These permit athletes to train harder, recover more quickly and build more muscle, but they can lead to kidney damage and increased aggression. Anabolic agents, peptide hormones, growth factors and related substances and mimetics and beta- 2 agonists are assumed in order to increase the muscle mass (Stiegel et al 2010). Moreover, the last two classes of substances and stimulants and the method of manipulation of blood and blood components are useful for increasing of endurance and for increasing of reactivity and aggression, athletes take stimulants, narcotics, cannabinoids, glucocorticosteroids and alcohol (Strano et al, 2011). Moreover, in order to mask the assumption of drug, the athletes take hormone and metabolic modulators and diuretics and masking agents (Table 1).

Table 1. 2017 Wada prohibited substances and methods

Substances and methods prohibited in and out competition
S1 Anabolic agents
S2 Peptide hormones, growth factors, related substances and mimetics
S3 Beta- 2 agonists

S4 Hormone and metabolic modulators S5 Diuretics and masking agents M1 Manipulation of blood and blood components M2 Chemical and physical manipulation M3 Gene doping
Substances and methods prohibited in competition
In addition to the categories S1 to S5 and M1 to M3, S6 Stimulants S7 Narcotics S8 Cannabinoids S9 Glucocorticosteroids
Substances prohibited in particular sport
P1 Alcohol P2 Beta-blockers

MATERIALS AND METHODS

This is a descriptive study, consisting of a bibliographic review of the presence of substances/metabolites/markers prohibited by the WADA in the Italian sporting context during the period 2003 -2016. The inclusion criteria were literature search, was performed on PubMed and Scopus database and Italy Anti-doping official website. Data showed are originated from the report commissioned by the Italian Ministry of Health. Indeed, every year -since 2003- anti-doping tests carry out. Perhaps it is possible to know the spread year per year of doping in Italy. The authors have compared the above mentioned data in order to show doping's spread in this period. Table supports the comparison.

RESULTS

The search strategy retrieved have to know that the prohibited substances and/or the amount of substance prohibited constantly change: some of them have been eliminated over time while others have been added. For example, pseudoephedrine and norephedrine were removed from the list in 2003 but in 2013, the first substance was reintroduced with a different dosage. Local anesthetics and caffeine were eliminated in 2004 (Strano Rossi et al, 2011), even if the substance has been included in the monitoring program of WADA in 2015. Since 2003, the Commission carried out doping tests. The tests collected only urine samples (Badoud et al, 2013; Mazzeo et al. 2017).

Analyzing the consumption of prohibited substances and considered that the control activities of the Anti-Doping Commission began in April 2003, in that year there was a high consumption of stimulants equal to 40%. The lowest percentages are 10.3% in 2010 and 6.7% in 2013. Compared with the year 2012, consumption fall by 13 percentage points. The average consumption from 2003 to 2016 is 19.3%.

The cannabis derivatives have a peak of consumption in 2005 and 2007, respectively, with 42.6% and 42.3%. Their use in the other years is characterized by ups and downs: it should be noted, indeed, that in 2012 the percentage is 31.8%, while in 2013 is 16.7%. The lowest consumption occurred in 2014 with the 3%. The average consumption is 22.6%.

Regarding diuretics and masking agents, they have almost a constant trend over the years. The peak is reached in 2014 with 26.7% and in 2008 it was recoded the lowest percentage: 3,4%. The average consumption of this type of substances is 16.5%.

Anabolic agents experienced a sharp increase in their consumption in 2010 and 2013, respectively with 37.1% and 35%. The average consumption is 18.4%%.

Corticosteroids have a peak in 2016 with 21.2% and the lowest consumption in 2007 with 3.8%. The average consumption is 9.5%.

Hormones and related substances have a low consumption with 2.1% and spike in consumption in 2008 to 25.4%. The trend in consumption was fluctuating and the average is 10.4%.

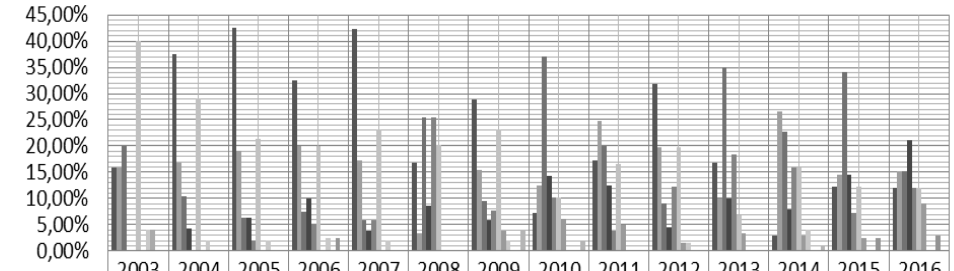
Beta-2 agonists have been banned since 2009. Their peak occurred in 2016 with the 9.1% of consumption and, after a brief decline in 2012 by 1.5%. Its average consumption is 4.2%.

Beta-blockers are irrelevant over the years. There are no data for 2013 and its average fuel consumption is 2.5%.

Another exception should be made for local anesthetics as they were prohibited only in 2003.

Regarding agents with anti-estrogenic activity and narcotics, the consumption has been detected only in few years with low percentage (Table 2, Table 3).

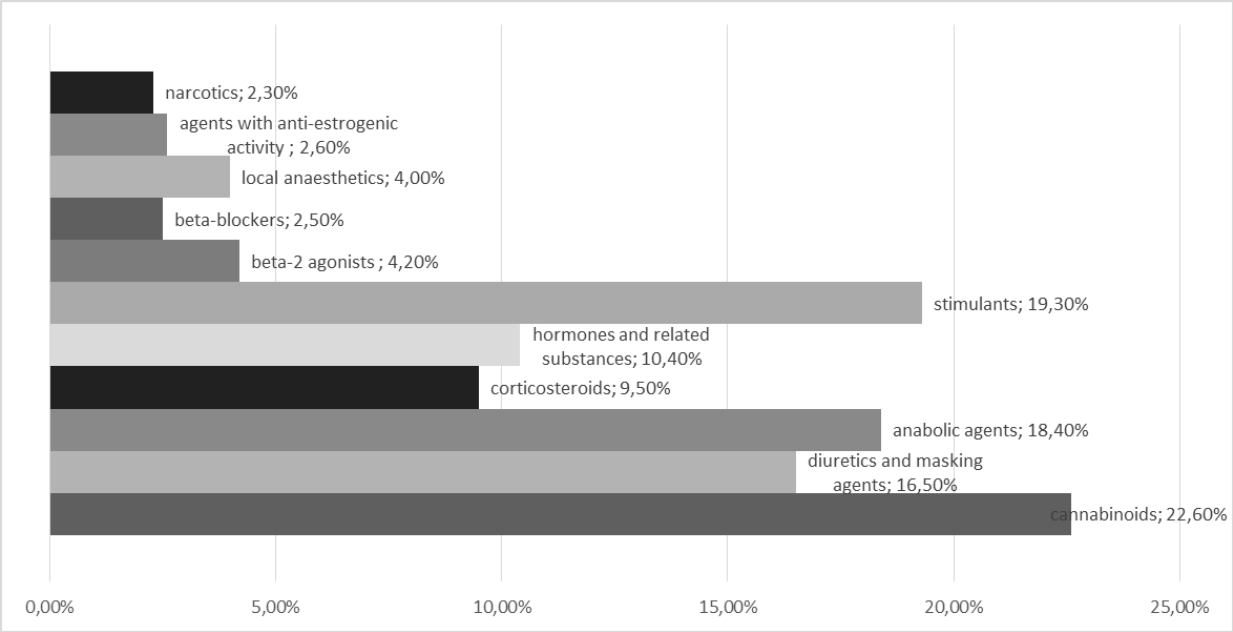
Table 2. Consumption of prohibited substances over the years. Breakdown per classes of substances and for years. Values are expressed in percentages. Reference period: 2003-2016



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
cannabinoids	16,00%	37,50%	42,60%	32,50%	42,30%	16,90%	28,80%	7,20%	17,30%	31,80%	16,70%	3,00%	12,20%	12,10%
diuretics and masking agents	16,00%	16,70%	19,10%	20,00%	17,30%	3,40%	15,40%	12,40%	24,80%	19,70%	10,00%	26,70%	14,60%	15,20%
anabolic agents	20,00%	10,40%	6,40%	7,50%	5,80%	25,40%	9,60%	37,10%	20,00%	9,00%	35,00%	22,80%	34,10%	15,20%
corticosteroids*		4,20%	6,40%	10,00%	3,80%	8,50%	5,80%	14,40%	12,50%	4,50%	10,00%	7,90%	14,60%	21,20%
hormones and related substances			2,10%	5,00%	5,80%	25,40%	7,70%	10,30%	3,80%	12,20%	18,30%	15,80%	7,30%	12,10%
stimulants	40,00%	29,20%	21,30%	20,00%	23,10%	20,30%	23,10%	10,30%	16,60%	19,70%	6,70%	15,80%	12,20%	12,10%
beta-2 agonists ***							3,80%	6,20%	5,00%	1,50%	3,30%	3,00%	2,40%	9,10%
beta-blockers	4,00%	2,10%	2,10%	2,50%	1,90%		2,00%			1,50%		4,00%		
local anaesthetics**	4,00%													
agents with anti-estrogenic activity				2,50%									2,40%	3,00%
narcotics							3,80%	2,10%				1,00%		

** recognized only since 2004 ** not prohibited after 2003 *** recognized from 2009*

Table 3. Percentage of consumption of prohibited substances over the years. Breakdown per classes of substances. Values are expressed in percentages. Reference period: 2003-2016



** recognized only since 2004 ** not prohibited after 2003 *** recognized from 2009*

DISCUSSION

Literature shows that the substances that give pleasant sensations or help the subject in his activity will bring him to repeat the consumption (Duda et al, 1992; Santamaria S., et al 2014; Stella et al 2005). The reported data showed the high consumption of certain drugs (Striegel H. et al, 2010). Stimulants are used because they increase the ability to concentrate, alertness and safety. They also increase the aggressiveness and the sense of competitiveness. To anabolic are recognized the following effects: euphoria, sense of well being, glee, increased motivation and self-esteem (Mazzeo, 2016). Moreover, the athlete doesn't get bored during the training. Narcotics have a calming effect on the psyche as well as beta-blockers reduce the anxiety and stress. Corticosteroids have, instead, a stimulating effect like alcohol. Moreover, to corticosteroids are recognized: euphoria, increased sociability and sense of well-being. Cannabinoids, such as cannabis, hashish and marijuana, cause changes in mood and perception, euphoria, happiness, relaxation and deep sleep and reducing anxiety. They are considered drug to use social-recreational. (Technische Universität München; Tevis , 2014).

WADA, in 2004, drew up a Code that is constantly emended. The Code explains the definition of doping and contains sanctions too. Others instruments used to contrast doping are the accredited laboratories, the biological passport and the ADAMS (Overbye et al., 2013).

The laboratories have an important role in the discovery of new substances. They also determine the quantitative of those substances, carry out anti-doping tests. Currently, there are 32 laboratories in the World (Table 4) (Valkenburg et. al, 2014).

The Biological Passport is a tool for indirect detection of the presence of a doping substance in biological samples of an athlete. With it, in fact, the changes of certain bio-markers of doping are recorded and

monitored. If the data, combined with the personal data localization in a given period, exceeded a certain range, the athlete would assume the banned substances (Lippi et al. 2008; Thevis et al, 2014).

The Anti-Doping Administration and Management System (ADAMS) is an on-line database system where are recorded all data: laboratory results, therapeutic use exemptions (TUEs) and information on anti-doping rule violations. It allows the sharing of information amongst the organizations and promotes efficiency, transparency and effectiveness in all anti-doping activities (Møller, et al, 2014).

Table 4. Anti- Doping laboratories in the World

State	City	Note
AUSTRALIA	Sydney	
AUSTRIA	Seibersdorf	
BELGIUM	Ghent	
BRAZIL	Rio de Janeiro	
CANADA	Montreal	
PEOPLE'S REPUBLIC OF CHINA	Beijing	
COLOMBIA	Bogota	The WADA accreditation of the Laboratorio de Control al Dopaje Coldeportes Nacional Bogota – Colombia was suspended from conducting anti-doping testing for a period of six months effective 20 February 2017. Following the expiry of this initial suspension period, the laboratory's suspension was extended for an additional period of up to six months to address outstanding non-compliances.
CUBA	Havana	
FINLAND	Helsinki	
FRANCE	Paris	
GERMANY	Cologne Kreischa	
GREAT BRITAIN	London	
GREECE	Athens	
INDIA	New Delhi	
ITALY	Roma	
JAPAN	Tokyo	
KOREA	Seoul	
MEXICO	Mexico	The WADA accreditation of the Laboratorio Nacional de Prevencion y Control del Dopaje-CONADE, Mexico was suspended from conducting anti-doping testing for a period of six months effective 23 November 2016. Following the expiry of this initial suspension period, the laboratory's suspension was extended for an additional period of up to six months to address outstanding non-compliances.
NORWAY	Oslo	
POLAND	Warsaw	

PORTUGAL	Lisbon	suspended from conducting anti-doping testing for an undetermined period effective as of 15, April 2016.
QATAR	Doha	
ROMANIA	Bucharest	
SPAIN	Barcelona	
	Madrid	suspended from conducting anti-doping testing for an undetermined period effective as of 6, June 2016.
SWEDEN	Stockholm	
SWITZERLAND	Lausanne	
THAILAND	Bangkok	
TURKEY	Ankara	
UNITED STATES	Los Angeles	
	Salt Lake City	

CONCLUSIONS

Doping is a phenomenon characterized by clandestineness (Mazzeo et al. 2016). The anti-doping tests provide insufficient data for statistical extrapolations and accurate estimates of the phenomenon, because of the small number of athletes tested and the imprecision of the methods of research (Sadeghi Pour, et al., 2009). The lack of statistical significance is due precisely to the low sampling of the tests, compared to tens of millions of athletes engaged in sports practices also outside of the vertices competitive (Ferrara, 2004).

Athletes subject to Italian and WORLD drug antidoping testing may be subject to both in- and out-of-competition testing. At the present, the tests are based on urine samples (Mazzeo et al, 2018) . Blood tests should enable verification of the level of haematocrit or haemoglobin. This type of analyses based on more specific parameters (direct or indirect) could well reveal forms of doping that cannot be detected in urine (de Mérode et. al, 1999).

To confirm what said up to now, on April 2006, DOXA Institute submitted 508 athletes to an anonymous questionnaire about beliefs on and attitude on doping of Italian athletes. They “confessed” that the tests are infrequently and poorly effective and they should be more frequent and follow a different protocol (Tavani et al., 2012).

Inappropriately, today, although the technological advancement that characterizes the field of scientific research, the analytical methods are not sufficiently dependable for the search of the complete group of substances included in the anti-doping lists (Mazzeo et al., 2016).

Another inquiry is the great difficulty to anticipate the moves of the opponent and this, therefore, is not easy to understand what new substances will be taken and what new methods will be adopted (Ministero della Salute 2013). Anyway, close collaboration among the accredited laboratories would enable them to keep up to date and exchange new techniques. Closer ties with the pharmaceutical industry and those involved in basic research are also vital if they are to be able to anticipate new tendencies and forms of doping by means of a sort of scientific “vigil” (Marcley et al, 20. The instrumentation and measurements industry would also be able to give them the benefit of recent progress in their domain (de Mérode, et al. 1999).

Furthermore, the purposes of the World Anti-Doping Program and the Code are to protect the athlete's fundamental right to participate in doping-free sport and thus promoting health, fairness and equality for athletes world wide. Potentially risks to health by doping are taken in the pursuit of sporting excellence (Mazzeo, et. al., 2015) . The increasing profile of sport for athletes with a disability, and its potential rewards, has led some athletes to seek improved performance through the administration of prohibited substances.

Moreover, is essential for economic and social development that the health sector is responsible for: developing and implementing national and subnational health strategies (Mazzeo, 2016).

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